CREW CENTRE OF EXPERTISE FOR WATERS

Review of psychoactive substances wastewater monitoring approaches

Policy Brief

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Key Messages

- **This study explored the use of wastewater-based epidemiology monitoring approaches (WWBE) to augment current data on psychoactive substances and provide timely and robust drug monitoring.**
- **Recommendations were given on which psychoactive substances represent the highest public health threats in Scotland. These substances include drug classes such as hallucinogens, stimulants, depressants, synthetics, and other new psychoactive substances.**
- **Analytical approaches which have been implemented internationally exist for all target substances. Suitable analytical instrumentation is widely available in laboratories in Scotland for undertaking wastewater analysis.**
- **Existing sampling activity, where possible, can be adopted for the purpose of monitoring psychoactive substances and would maximise resources.**
- **By providing near real-time data with a turnaround time of approximately 1 week, WWBE monitoring offers consumption estimates not readily available by other means.**

Summary

Scotland faces a significant public health challenge with one of the highest levels of drug-related deaths in Europe. While recent studies have attempted to understand prevalence using modelling of existing data (Health Scotland, 2024) the data set and substances evaluated remains limited. Existing approaches to assess illicit drug use provide critical public health information, but these approaches can be time consuming, may not capture rapid changes in substance use and do not provide population-level datasets. Wastewater monitoring has the capacity to augment information provided to Scotland's Rapid Action Drug Alerts and Response (RADAR), providing near-real time information on drug use patterns (Sims *et al*., 2021). This study combined systematic approaches including literature review, evidence mapping, and engagement of key stakeholders and experts to demonstrate the feasibility and benefits of using the current wastewater influent monitoring infrastructure to track psychoactive substances and their metabolites in Scotland.

Recommendations

- Wastewater monitoring is used globally to augment understanding of drug use patterns. Pilot schemes should be trialled in Scotland to establish and develop practical implementation.
- Wastewater has been useful in monitoring COVID levels nationally. Existing sampling platforms should be adapted to facilitate monitoring of psychoactive substances.
- The complex nature of New Psychoactive Substances (NPS) has traditionally presented an analytical challenge that may be overcome by wastewater monitoring using advanced laboratory instrumentation. Monitoring should emphasise the identification of both established and novel substances using both targeted and non-targeted analytical screens.
- At least 15 public and privately-funded research facilities in Scotland have appropriate instrumentation and expertise to undertake the relevant analyses and should be considered for pilot studies. Given the restricted funding environment, wastewater-based epidemiology trials should focus on a select number of samples/target substances prior to expansion at a national level.

- Trials should involve the major stakeholders from public health and water industry. Trials would benefit from academic and statistical input into the development of sampling regimes, optimisation of detection methods and development of data analysis pipelines.

Research undertaken

1. Target Psychoactive Substances

A list of target substances which should be monitored to address the highest public health threats for Scotland were identified through discussions with stakeholders and literature reviews. Due to the dynamic nature of many of these substances, the substances were broadly grouped into drug classes including, but not limited to, amphetamine-type stimulants, benzodiazepines, cannabinoids, depressants, novel synthetics, other illicit pharmaceutical substances, and other stimulants.

2. Analytical Strategies

Internationally recognised analytical strategies were identified through literature searches and evidence mapping for all target substances. Identification was most often achieved using tandem liquid chromatography – mass spectrometry (LC-MS/MS) for known compounds that are non-volatile and water-soluble. By contrast, high resolution MS (LC-HRMS) and database comparison was suitable for volatile compounds or situations where the identity of substances is unknown or novel.

3. Infrastructure

Scottish Water undertakes routine sampling across many treatment works to comply with regulatory monitoring requirements. Sampling frequency ranges from four times per week to quarterly, with larger works being sampled more frequently. Most works are equipped with autosamplers which collect composite samples over 24 hours. They also undertake additional sampling for specific projects and have the capability to combine these with existing sample collection to maximise efficiency and resource use. Existing wastewater influent sampling infrastructure is available as developed to undertake COVID monitoring. A network of sample receipt depots and internal couriers facilitate transportation of samples for laboratory analysis. Additional resources would be required for any significant additional sampling effort.

A lack of searchable instrumentation at over 850 accredited laboratories within the UK necessitated narrowing an online search to government-funded facilities, private institutions, research consortiums, and university research centres within Scotland. At least 15 sites were identified as carrying instrumentation applicable for wastewater monitoring with current research focused in the medical, environmental, forensic, and health science fields. It was not noted whether these sites have the necessary analytical accreditation or standards to carry out testing.

4. Data Analysis Pipelines

Based on a search of recent literature, no specific information identified on how long it would take to develop a pipeline for routine analysis of psychoactive substances, nor did any studies report a time period from sampling to the production of raw data and formatting for reporting. Based on experiences from data analysis for COVID monitoring, we estimate that with sufficient laboratory capacity and resources for analysis, psychoactive substance monitoring system should not take more than a week from sampling to data reporting, which is in line with the (near) real-time description of schemes described in the literature.

5. Benefits of Wastewater Monitoring

Utilising literature compiled during the project and through informal interactions with experts in the field, the following key overarching benefits of applying wastewater monitoring of psychoactive substances to enhance existing drug use data were identified:

1. Additional and timely intelligence of changes in both the types and levels of consumption of psychoactive substances.
2. Informs public health response by adding to current near-to-real-time public health surveillance systems to monitor established, as well as new, and emerging trends.
3. Informs national policies to better understand Scotland's prevalence in terms of drug use.
4. Provides a better understanding of drug use in Scotland in context with other countries, by providing an opportunity to utilise directly comparable data of the living population.

Conclusions

This feasibility study has highlighted clear benefits of implementing wastewater monitoring studies in Scotland that promote information availability, public awareness of health threats, and active monitoring. These benefits emphasise the importance of wastewater analysis as a supplemental component to traditional testing. The study findings demonstrate that the infrastructure, expertise, and analytical instrumentation are available within Scotland to establish and support a monitoring programme. Furthermore, analytical methodology has been successfully implemented worldwide in similar wastewater monitoring studies which can be adopted to use in Scotland. Pilot schemes will establish the necessary foundation needed for WWBE of psychoactive substances to be successful at a national level.

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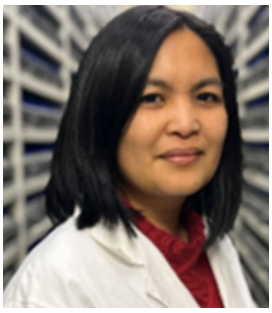

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Eulyn is a Senior Environmental Microbiologist at the James Hutton Institute. Her work on wastewater-based epidemiology includes tracking Salmonellosis and enteropathogenic *E. coli* in the community. She also used it as a tool to detect bacterial markers for sewer crown corrosion as an early warning system to target infrastructure maintenance.

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